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**Montana
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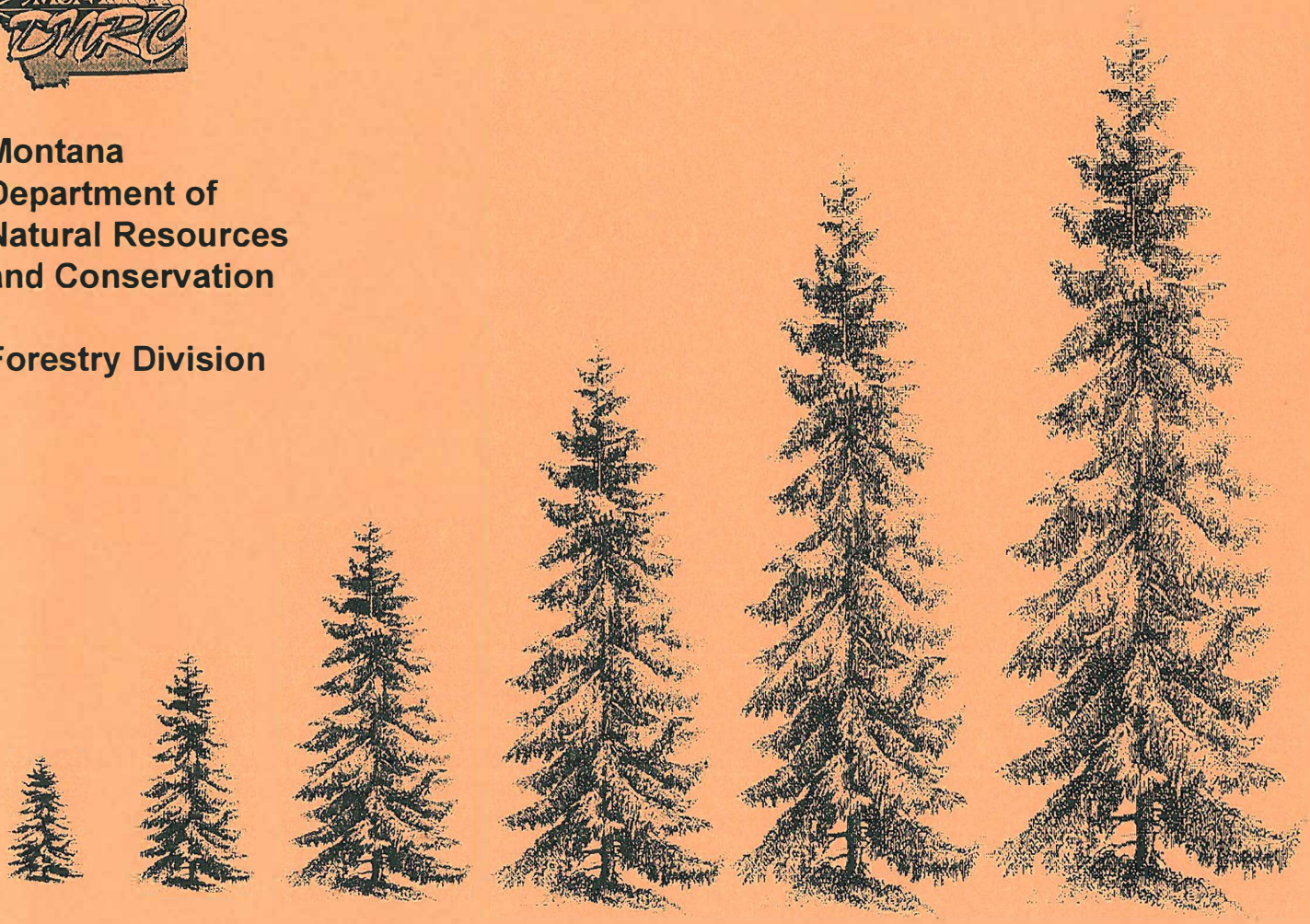
Forestry Division

Montana

Forest Insect and Disease Conditions and Program Highlights 1996



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Report 97-2

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INTRODUCTION

This report summarizes the major forest insect and disease conditions in Montana during 1996 and was jointly prepared by Forest Health Protection, State and Private Forestry, Northern Region, USDA Forest Service and the Montana Department of Natural Resources & Conservation, Forest Division. Information for this report was derived from ground and aerial surveys conducted across most of Montana.

SUMMARY OF CONDITIONS

Across the State, bark beetle populations have been again in a general decline, except for ongoing outbreaks of mountain pine beetle mortality to lodgepole pine in extreme western Montana, and the mortality to subalpine fir at higher elevations in all of western Montana, and especially in southwestern Montana on the Gallatin and Beaverhead National Forests. Douglas-fir beetle caused mortality is slightly less than in 1995. Since the high population build up of pine engraver in 1995 after the dry summer of 1994, populations dropped to almost undetectable levels in 1996.

For the second year in a row no western spruce budworm defoliation was visible from the air in Montana. Low western spruce budworm populations still prevail across most of the western United States. No Douglas-fir tussock moth or pine tussock moth defoliation was observed in 1996. The isolated outbreak of western false hemlock looper north and south of Helena continued for a second year.

With the exception of foliage diseases, forest disease populations fluctuate very little compared to forest insect populations. Mortality and growth losses from root diseases and dwarf mistletoes continue to be high throughout the State. Root disease-caused mortality is more common west of the Continental Divide though large root disease patches can be found east of the Divide.

Dwarf mistletoe continues to cause extensive growth losses and mortality across the State; losses total approximately 33 million cubic feet annually. Douglas-fir west of the Divide, western larch and lodgepole pine are the tree species most severely affected.

White pine blister rust continues to be present throughout the range of five-needle pines in the State. The rust severity is highest in the northwestern part of the State where the disease has caused extensive mortality in white pine and whitebark pine. The rust does occur in limber and whitebark pine on the eastside as well, but at this time, disease incidence is relatively low and mortality is uncommon.

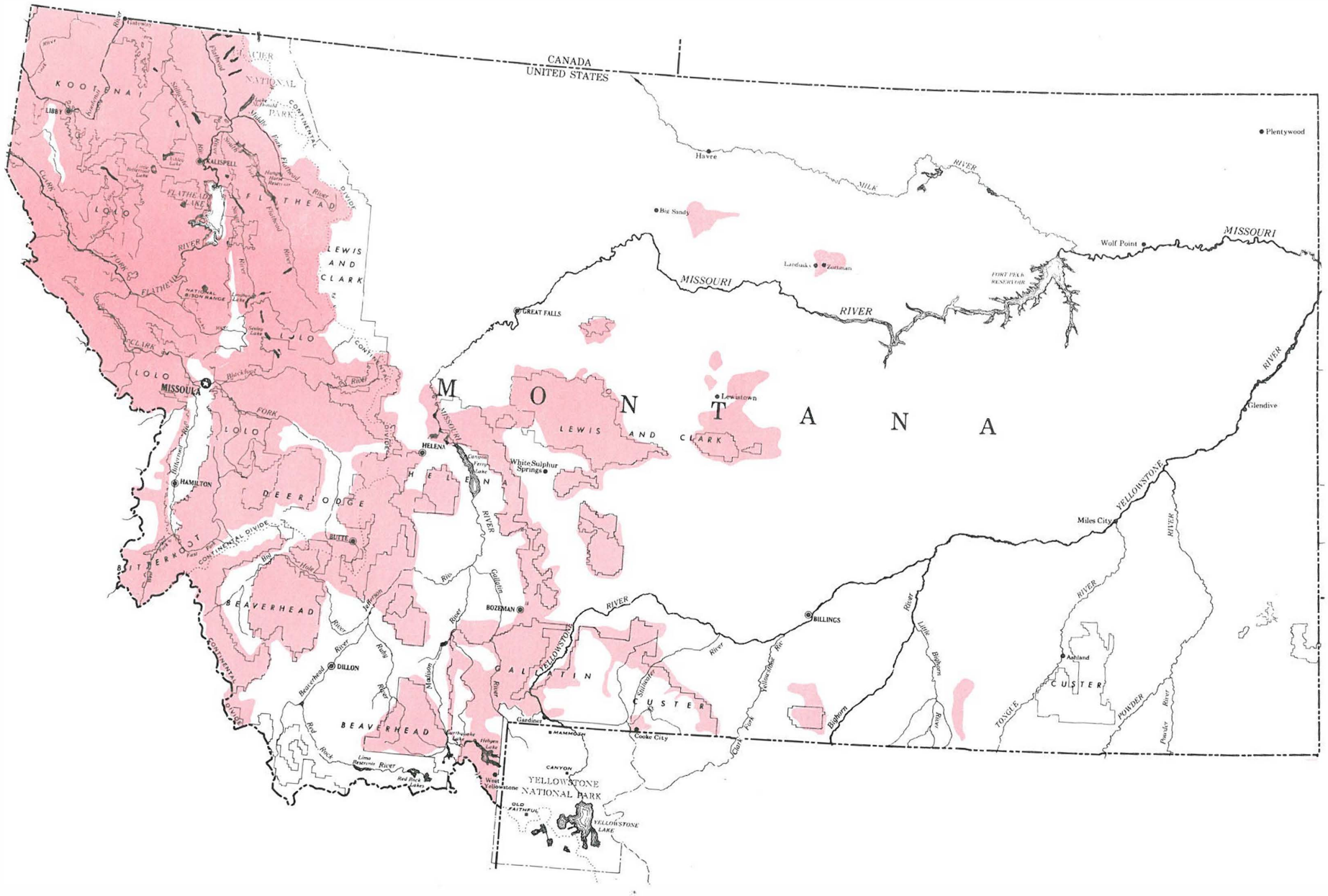
Larch needle cast increased dramatically in 1996 across the host type in western Montana. Lodgepole pine needle cast appears to have reduced to low levels after 5 years of high intensity.

ANNUAL AERIAL SURVEY

The annual aerial survey in Montana was conducted from June 28 to September 11, 1996. The state was surveyed in approximately 240 aircraft flight hours at a cost of $52,500 covering approximately 22.5 million acres of forested land, excluding most wilderness areas.

Much of the data summarized in this report is a product of this aerial survey as well as ground surveys and biological evaluations. Along with the data summaries, aerial survey maps are available from the Forest Health Protection Field Office in Missoula in both paper copies and in digitized GIS format.

The annual aerial survey is an overview survey designed to cover large areas in relatively short periods of time. Priority forest disturbances include bark beetle caused mortality, defoliators and windthrow. If forest disturbances activity is low, secondary attributes such as diseases, needle damage and high-water damage are sketch mapped. The survey covers each area once a year during which time the observer sketch maps as many forest disturbances as possible. The survey is conducted using a single-engine, high-wing airplane flying at speeds of approximately 90 to 120 mph, at an average altitude of approximately 1,000 to 2,000 feet (above ground level).



Areas of coverage during the 1996 Aerial Detection Survey in Montana.

INSECTS

Bark Beetles by Area

The marked increase in bark beetle-caused mortality, noted in 1995, and resulting from unusually warm and dry conditions of 1994, was short-lived. For the most part, bark beetle populations, and their effects, returned to levels more similar to patterns established in the early 1990's. The mountain pine beetle outbreak on the Lolo National Forest in lodgepole pine continues to intensify in the same general area. Ground survey data indicates high mortality again in 1997. Areas in which western balsam bark beetles were found expanded slightly in 1996, and acres infested by spruce beetles increased in Montana. Mortality attributed to most other bark beetle species, however, returned to approximately 1994 levels, or less.

The following table, and subsequent summaries, show infested areas and amounts of associated mortality, as obtained from aerial survey estimates. Not as many as we would have liked have been assessed by more definitive ground surveys. Still, these combined survey methods provide information on extent and intensity of beetle infestations that can scarcely be obtained in any other way. Without aerial surveys, and information thus garnered, assistance rendered to land managers striving to improve forest health, would be much more limited.

Table 1. Bark beetle infested acres, 1995-1996

Beetle	1994	1995	1996
DFB*	7,194	5,805	4,353
ESB	157	767	1,267
IPS	1,551	8,220	19
MPB	19,195	31,340	27,503
WPB	985	1,433	1,181
FE	318	349	401
WBBB	39,292	41,425	44,673

Note: The following abbreviations will be used throughout:

Beetles

DFB = Douglas-fir beetle, *Dendroctonus pseudotsugae* Hopkins
ESB = Engelmann spruce beetle, *D. rufipennis* (Kirby)
IPS = Pine engraver, *Ips pini* (Say)
MPB = Mountain pine beetle, *D. ponderosae* Hopkins
WPB = Western pine beetle, *D. brevicomis* LeConte
FE = Fir engraver, *Scolytus ventralis* LeConte
WBBB = Western balsam bark beetle, *Dryocoetes confusus* Swaine
RTB = Red turpentine beetle, *D. valens* LeConte

Hosts

LPP = Lodgepole pine
PP = Ponderosa pine
WWP = Western white pine
WBP = Whitebark pine
DF = Douglas-fir
GF = Grand fir
SAF = Subalpine fir
ES = Engelmann spruce

Reporting area summaries follow. For each, bark beetle effects on their respective hosts are noted. To the extent possible, we have tried to portray areas affected, an estimate of impacts, and population trends. Though reporting areas are designated, in most cases, by Forest names; there are, within those reporting areas, lands of various ownerships--federal, state, and private.

Beaverhead NF

Many, large polygons of WBBB-killed SAF were observed on the Forest. Most were concentrated on Madison RD, but some on Sheridan RD as well. Largest groups, up to 700 trees, were seen near West Fork Rest Area. Many groups, of 50-200 trees, were located

near Divide Mountain, Windy Hill, and Strawberry Butte (Madison RD). Smaller, scattered groups occurred near Antone Peak (Sheridan RD). A few small and scattered groups of SAF, killed by WBBB, and small groups DFB-affected DF were noted near Balanced Rock Campground and between Cloudrest Peak and Old Bald Mountain (Sheridan RD). A few groups of WBBB-impacted trees were seen near Ulerys Lakes and Fan Mountain (Madison RD), within the Jack Creek drainage.

Numerous groups of faded SAF, attacked by WBBB, were mapped near Bender Point and Wooster Mountain and in tributaries of Ruby Creek, all in the Beaverhead Mountains (Wisdom RD). Fewer, and more scattered groups of dead SAF were observed throughout the Pioneer Mountains on Wise River RD. In the Pioneers, a few, small groups of MPB-killed LPP were noted, as well. A few groups of DFB-attacked DF were noted on the eastern portion of Wise River RD. Much of the Dillon RD was not flown in 1996.
The only bark beetle species of significance on the Forest, in 1996, was WBBB. Forestwide, more than 12,000 SAF were killed on just over 18,000 acres.

Bitterroot NF

Small, scattered groups of both LPP and PP, killed by MPB; and old growth PP, attacked by WPB, were observed along eastern slopes of the Bitterroot Mountains, from Mormon Creek on the north to Darby on the south (Stevensville and Darby RDs). Scattered, 3- to 5-tree groups of MPB-infested PP were recorded in the Sapphire Mountains, east of the Bitterroot Valley, mostly on Stevensville RD. Highest concentrations of those beetle-killed trees were near Spring Gulch and Squaw Peak, south and east of Stevensville.

Additional groups of PP, killed by WPB; and DF, affected by DFB, were mapped on the east side of Darby RD, in the Skalkaho Creek drainage. Southeast of Hamilton, more MPB-killed PP were noted within Sleeping Child drainage and from there, southward (Darby RD). More concentrated groups of MPB-infested PP were PP stands, and WBBB affecting SAF, were light and scattered.

Fewer and more scattered groups of PP, killed by MPB and WPB; as well as DFB-killed DF, were noted within East Fork Bitterroot River drainage. Similar, widely scattered conditions were found to the south, along Camp Creek, on the Sula RD. Many, but small groups of MPB-killed PP were seen near Painted Rocks Reservoir. A few LPP were found to have been killed by MPB in small groups near Salamander Butte on West Fork RD. Occasional, small clusters of trees, killed by DFB, WBBB, and MPB--in both LPP and PP--were throughout the Selway-Bitterroot Wilderness.

In total, bark beetle species on the Forest infested only a little more than 1,000 acres, with MPB in PP being the majority. Slightly less than 2,000 dead trees were recorded.

Custer NF

Intermittent, small groups of MPB-killed LPP were mapped north and west of Red Lodge, on Beartooth RD. A few small groups of DF, killed by DFB, were also found east of Meyers Creek Guard Station. Many 10- to 30-tree groups of WBBB-killed SAF were seen within Rock Creek drainage, west and south of Red Lodge and along Beartooth Highway, towards the WY/MT State line. In addition, a few groups DF and ES, killed by DFB and ESB, respectively, were noted in that general area--from about Sheridan Campground to Vista Point.

Numerous, large groups of DF, killed by DFB--some as large as 150 trees; and WBBB-killed SAF, in 20- to 60-tree groups, were observed in the Pryor Mountains, along tributaries of Crooked Creek. Biggest concentrations of DFB-killed trees were in an area known as Big Coulee. A single group of MPB-killed LPP was observed near Big Pryor Mountain, also on Beartooth RD.

Of the 1,500 acres recorded containing some bark beetle-caused mortality on the Forest, nearly half were infested by DFB. Total mortality, all species, was about 1,800 trees.

Deerlodge NF

Scattered groups of PP, killed by combinations of MPB and WPB, were noted south of I-90 in Harvey Creek drainage--mostly on private lands within the boundaries of Philipsburg RD. Also widely dispersed clumps of LPP, infested by MPB, and SAF, killed by WBBB, were mapped east of Philipsburg. Those groups were numerous, but small--of 10-20 trees each. Most of that mortality was observed in Flint Creek Range from Dora Thorn Ridge to Forest boundary. Some PP was recorded as having been killed by WPB, but in that area, it was more likely to have been MPB.

A few small groups of SAF, which had been killed by WBBB, and MPB-killed LPP were noticed on Deerlodge RD, east of Sugarloaf Mountain. An additional small number of LPP, also killed by MPB was located near Basin; and south of there, near Elk Park Campground and Delmoe Lake. These small groups of dead trees are but a remnant of the once-extensive infestation that existed in that area.

Forestwide, about 1,600 acres were infested by bark beetles. Most were MPB. Approximately 1,300 trees, mostly LPP, were killed.

Flathead NF

Numerous groups of still-active DFB infestations were noted on Coram Experimental Forest. A few spots of FE-killed GF were observed east of the Experimental Forest boundary, on the Hungry Horse RD. Elsewhere on the District, WWP, killed by MPB was mapped in scattered and small groups along both sides of Hungry Horse Reservoir. South, towards Spotted Bear, DFB-killed groups of DF were still evident in the Spotted Bear River drainage, though that infestation has declined from recent years' levels. On other parts of the Spotted Bear RD, MPB populations appear to be increasing in LPP stands--particularly south and east of the Spotted Bear RS. Data collected from permanent plots, as well as other population-monitoring plots established in 1996, showed a slight increase in beetle activity. Elsewhere, many small scattered groups of WBBB-killed SAF, DFB-affected DF, and WBP, attacked by MPB, were observed. Some ESB-infested groups of ES were mapped along Bunker Creek and its tributaries, also on the Spotted Bear RD.

To the north, on the Swan Lake RD, still active groups of MPB-killed LPP were noted on Crane Mountain. That infestation, too, is not as extensive as in past years. Several groups of more than 200 trees, killed in 1995, do exist there, however. Along both sides of Swan Lake, small scattered groups of MPB-killed WWP, FE-killed GF, and DF, attacked by DFB, were observed.

A small number of LPP and PP were found to have been killed by MPB on the "Island Unit" of the Swan Lake RD. In the southern portion of that Unit, north of Lake Mary Ronan, a few old-growth PP have been killed by WPB. South of there, near Browns Meadow Pass, nearing the Flathead IR, several more groups of WPB-killed PP were located.

On the Tally Lake RD, some widely scattered, small groups of GF, killed by FE; MPB-infested LPP; and WBBB-killed SAF were found. Several small groups of DFB-killed DF were mapped east of Tally Lake. In addition, there exists some concern about the possibility of an ESB outbreak on the western edge of Tally Lake RD, where windthrown and fire-affected ES have been infested by ESB. Salvage efforts are underway, but that population will have to be monitored closely for the next couple of years.

To the north, on the Glacier View RD, a few groups of WWP, killed by MPB were noted in Canyon Creek and nearby drainages, north of Columbia Falls. Similar beetle-caused mortality was also widely scattered on the Stillwater SF, to the west of there, but east of Stillwater River. Numerous groups of WBBB-killed SAF were mapped throughout North Fork Flathead River watershed; and there were still isolated groups of DFB-caused mortality within the Coal Creek drainage (Glacier View RD)

Several bark beetle species caused significant amounts of mortality on the Forest in 1996. Most widespread was MPB, infesting LPP stands. More than 1,000 acres of LPP contained some beetle-caused mortality. Damage attributed to WBBB was found on more than 800 acres, DFB on 540 acres, and ESB on almost 300 acres. Another 300 acres contained WWP killed by MPB. In all, more than 5,000 trees were killed, by all beetle species.

Gallatin NF

A very few, small groups of WBBB-killed SAF and DFB-killed DF were observed in the southern end of the Bridger Mountains (Livingston RD), and some additional mortality caused by DFB on private land west of Livingston. Numerous groups DFB-caused DF mortality were found in Mill Creek and its tributaries, south of Livingston. That infestation has been extant for several years, and while decreasing, some groups remained active. Group size ranged from 5-30 trees. Additional DF, killed by DFB and found in small groups, was mapped in Sixmile drainage, and near Pine Creek Campground.

Numerous groups WBBB- and DFB-killed trees were located in the Boulder River drainage (Big Timber RD)--many concentrated around Hicks Park. One group there contained 200 dead DF. Also within that watershed, near Independence Peak, several groups of

WBBB-infested SAF, and three larger groups--of up to 80 trees each--showed ES mortality caused by ESB.

Near East Boulder Campground, several groups of DFB-caused faded DF, some LPP killed by MPB, and ESB-caused mortality were also noted. East of there, in upper portion of Deer Creek, several groups WBBB-killed SAF were found. Other SAF mortality, caused by WBBB, was mapped in scattered groups in upper-elevation stands on both Livingston and Big Timber RDs.

Near Cooke City, on the Gardiner RD, several groups ESB-, WBBB-, and MPB-caused mortality were evident. Tree species killed were ES, SAF, and WBP, respectively. Some large groups of dead ES--some up to 400 trees--were found near Lulu Pass. Those outbreaks were likely remnant populations which had their genesis in the 1988 fires. Numerous groups DFB- and WBBB-killed trees were also found on the western portion of Gardiner RD, near Deaf Jim Knob (DFB) and Sawtooth Mountain (WBBB).

Hundreds of polygons, representing thousands of dead trees, were mapped throughout SAF stands, from Bozeman south to West Yellowstone. Heavy concentrations were located near Lone Mountain and Big Sky ski area, as well as upper Porcupine Creek drainage, east of there (Bozeman RD). Other large groups, up to 1500 trees, were found north of Taylor Creek and southeastward into Cabin Creek Recreation and Wildlife Management Area.

Many large groups of WBBB-caused mortality were likewise found south of Hebgen Lake (Hebgen Lake RD). Fewer and smaller groups were located west of West Yellowstone, near Targhee Pass. Minor amounts of MPB-killed LPP and WBP were mapped north from Hebgen Lake, throughout the Gallatin Canyon. Some small amounts of DFB-killed DF were also observed at a few locations in the Canyon.

By far, the most significant bark beetle outbreak on the Forest was by WBBB in SAF stands. More than 24,000 acres were infested. DFB-caused mortality was observed on 740 acres, and ESB on about 660 acres. Forestwide, more than 26,000 trees were killed--about 90 percent of them SAF.

Helena NF

Many small, scattered groups of DFB-infested stands remained on Lincoln RD--mostly south of Blackfoot River and east of Nevada-Ogden Road. Some were mapped north of Lincoln, however; in Copper Creek drainage, and west of there, south of Coopers Lake. Most groups, though numerous, contain 20 trees or less. A few groups of ESB- and WBBB-killed trees were found in Copper Creek, as well. A few groups of PP which had been killed by MPB were noted east of the Forest boundary, in the vicinity of Holter Lake.

On the Helena RD, south and west of Helena, many small groups of PP have been killed by MPB. Many are near Sheep Mountain, but there are others south of there, as well. Also on the District, scattered groups MPB-killed LPP and WBBB-affected SAF were observed. Several groups of DFB-caused mortality were found near Marysville. Elsewhere on private lands within Helena RD boundaries, scattered groups of DFB-killed DF and PP, killed by MPB, were observed near Holter Lake. Some WBBB-caused SAF mortality was noted near Middleman Mountain and Indian Flats Campground. A few groups of MPB-killed PP were mapped close to Strawberry Butte, southeast of Helena.

On the Townsend RD, scattered MPB-caused mortality was observed in LPP stands in the southern portion of the Elkhorn Mountains and throughout the Big Belt Mountains east of Canyon Ferry Reservoir. In that same general area, WBP killed by MPB and SAF killed by WBBB, was seen throughout the Big Belts. None are major infestations, most groups being small and widely scattered. A few DFB-killed DF were noted east of Deep Creek Guard Station.

On the Helena, just over 1,000 acres were infested by all bark beetle species. Most were MPB in PP stands and DFB. Those two together accounted for more than 700 acres. A total 1,700 dead trees were recorded.

Kootenai NF

On Three Rivers (Yaak) RD, many scattered groups of MPB-killed WWP were found throughout the Yaak River drainage, some no doubt in association with BR. Also numerous small groups of LPP, killed by MPB, were noted in that area, with a significant concentration near Newton Mountain, where beetle populations remained active. DFB-affected DF was also commonly seen throughout the drainage.

On Rexford and Fortine RDs, only widely scattered small groups MPB-killed LPP, DF attacked by DFB and

SAF morality, caused by WBBB, was noticed. Some more concentrated groups of DFB activity was found near Pinkham Falls (Rexford RD).

Small groups PP, killed by both MPB and WPB, were recorded in several locations east of Lake Koocanusa, but were more numerous near Sheep Mountain, on the Fisher River RD. Elsewhere on that District, small scattered groups of MPB-infested LPP and PP, were concentrated near Meadow Peak. Some WPB-killed PP was more scattered.

On the Libby RD, scattered groups of LPP, killed by MPB, were mapped near Big Hoodoo and Little Hoodoo Mountains, and south of Libby to near Loon Lake. West of there, on Three Rivers (Troy) RD, DF was found to have been affected by DFB, but in a diffuse pattern of small groups. In a similar manner, MPB had impacted WWP stands, as had WPB affected PP stands.

On the Cabinet RD, no major outbreaks were noted, however, light MPB damage was observed throughout LPP and WWP host type. Significant numbers of root disease-affected stands were found throughout that part of the Forest. As a result, DFB and FE activity, associated with those weakened stands, was common. One area of note, which is typical of those concerns, is the entire Elk Creek drainage--for which long-range management plans are being developed.

The once extensive MPB outbreak, which less than 10 years ago covered more than 400,000 acres of LPP stands on the Forest, has declined to fewer than 800 acres in 1996. Forestwide, just less than 1,800 acres were infested by all beetle species. About 3,500 trees were killed in 1995.

Lewis & Clark NF

Scattered DFB-caused damage, in association with root disease, was observed in the Highwood Mountains, east of Great Falls. Minor amounts of MPB-killed PP was noted in the Blacktail Hills and west of there, to southwest of Stanford--all on the Judith RD. Very scattered, small groups of MPB activity in LPP stands; DFB-caused mortality in DF; and SAF, killed by WBBB, was mapped in the Little Belt Mountains, north of White Sulphur Springs. Small amounts of MPB-affected PP stands were seen in that area as well. More numerous amounts of PP, killed by MPB, were found near Judith Game Range and south to Indian Hill and Hay Canyon Campgrounds. Similar amounts of beetle-caused mortality was located in the eastern extremities of Little Belt Mountains, on both Judith and Musselshell RDs. Small groups of MPB-killed LPP and PP were noted in the Castle Mountains, as was beetle-caused mortality in PP stands in the Big and Little Snowies, southwest of Lewistown. Both areas are on the Musselshell RD.

Many scattered groups (1-20 trees) of both LPP and PP, infested by MPB were seen in the Judith Mountains, northwest of Lewistown (BLM-administered lands). Also noted were numerous groups of MPB-impacted PP stands, in the North Mocassin Mountains, north of Lewistown (BLM).

More than 2,700 acres were infested throughout the Forest and adjacent lands. Over half, 1,500 acres, were MPB in PP stands. Nearly 3,700 trees were killed.

Lolo NF

On the Missoula RD, many small, scattered groups of MPB- and WPB-killed PP, as well as DFB-affected DF were observed in the southeast portion of District--in the Sapphire Mountains, from Williams Gulch northward to Missoula. Concentrations of DF, killed by DFB, were noticed south of I-90, near Tyler Creek, west towards Burnt Mountain. PP stands, also impacted by both MPB and WPB were recorded near Dean Stone Mountain and surrounding Pattee Creek picnic area. Similar groups of trees were also noted south of I-90 southwest of Turah. North of Missoula, many groups MPB-killed PP were seen in the Rattlesnake drainage, west to Grant Creek, and from there north to Point Six. Some DFB-caused damage was noted at mid-elevations in that vicinity, as was WBBB-killed SAF, at higher elevations. Widely scattered groups of PP killed by IPS, and LPP-infested by MPB were noted in the eastern portion of the District. Similar infestation patterns of MPB in PP and LPP stands were mapped west of Missoula, to Lolo Hot Springs. Significant concentrations were noted in O'Brien Creek, Camp Creek and Hayes Creek drainages--all near Blue Mountain. A small amount of MPB-caused damage in LPP stands was observed in South Fork Lolo Creek and its tributaries. Of some concern on the District is the large amounts of windthrow which occurred in December 1995, throughout the Lolo Creek drainage and around Blue Mountain. Beetle infestations could yet result from areas not salvaged.

On the Ninemile RD, scattered groupings of PP, killed by MPB, were seen in a number of lower elevation stands within Ninemile Creek drainage. A large active group remained in a second-growth stand near Blue

Ridge. Some MPB-killed LPP was noted near Siegel Pass. In that same area were seen a few small groups of ES, killed by ESB. To the southwest, numerous small groups MPB-infested LPP and PP, as well as a small amount of DFB-killed DF were recorded in upper Fish Creek, near Clearwater Crossing. Scattered DFB- and MPB-caused mortality were noted elsewhere on the District. Significant amounts of blowdown, south of Clark Fork River--from Petty Creek west to Fish Creek and south to Lolo Creek--also occurred on the Ninemile RD.

The Superior RD is the site of a significant MPB outbreak in LPP stands, in two separate locations. One is at the head of Sloway Gulch and Miller Draw, where large polygons of 2,000-5,000 trees were mapped. The other is in upper Tamarack Creek drainage. There, polygons were recorded which contained 50,000-100,000 recently killed trees. Ground plots in both locations showed an average of more than 100 new attacks per acre in 1996. Those outbreaks range northward along Continental. Divide, onto Plains/ Thompson Falls RD. Elsewhere throughout the District, many widely scattered MPB and WPB "outbreaks" affected second-growth and old-growth PP stands. Some significant groups of MPB-killed LPP were also noted north of St. Regis.

Seeley Lake RD contained no major bark beetle outbreaks, however, numerous small groups DFB-caused mortality was observed from Ovando Mountain, northward and westward to Spread Mountain, and west to Cottonwood Creek and Black Canyon Creek. Most were groups of 10 trees or less. Scattered DFB-, WBBB-, and ESB-caused damage was found near Morrell Mountain. A few small groups of faded DF were seen near Sunday Mountain, and within Boles Creek drainage. Several small groups of MPB-killed PP were noticed from Ninemile Prairie, north to Boyd Mountain.

The Lolo NF and adjacent lands of other ownerships, contained the largest MPB outbreak in the Region. Nearly 13,000 acres of LPP were infested in 1996. Another 2,400 acres of MPB in PP was recorded, as was 900 acres of DFB in DF stands. Other beetles, in other hosts, were less numerous. Forestwide, slightly fewer than 190,000 trees were killed--182,000 of which were LPP.

On Plains/Thompson Falls RD, MPB infestations in LPP stands near Combest Peak and along Continental Divide, and from there scattered north nearly to Clark Fork River, are causing management concerns. Groups of 1,000-2,000 trees were evident in that area. Likewise, MPB-caused damage in LPP remained north of Plains, along Corona Divide, and into the Hinchwood Creek and Little Thompson River drainages. Though still active, these outbreaks were much smaller than ones recorded there only a few years ago. In that same general part of the District, MPB-caused damage was observed in PP stands east of Plains toward Seemer Peak and Rainbow Lake; with some notable amounts of MPB-killed LPP at higher elevations, towards Flathead IR. Elsewhere, scattered MPB-caused mortality in both LPP and PP stands; and some DF killed by DFB, was found on the northern and western part of the District. Surveys in upper Prospect Creek drainage revealed numerous small groups of MPB-caused damage in LPP, with much susceptible LPP remaining in that area. Also in that drainage, much FE- and DFB-caused mortality was noted--much of it no doubt associated with root disease impacted stands. MPB-killed WWP--some in combination with BR--was also recorded in Prospect Creek and associated drainages. MPB and WPB infestations, in low-elevation PP stands were mapped along the Clark Fork River, from Plains to west of Thompson Falls, near Cougar Peak

Garnet Mountains (BLM)

Many small, scattered groups of MPB- and WPB-killed PP were mapped throughout the reporting area, but WPB-caused damage is generally concentrated near Bonner. Most MPB-caused mortality was recorded from Diamond Mountain, east along the Blackfoot River to Ovando. Most mortality groups, attributable to either beetle, were comprised of 10 trees or less. Small, scattered clusters of DFB-caused mortality was noted between Bonner and Rainbow Bend. In the southern portion of area, PP mortality, attributed to MPB was found near Turah, and scattered along I-90 to east of Bearmouth. Several similar groups were also seen in Hoover Creek drainage, and east to Nevada Lake.

In the reporting area, about 2,300 acres were infested. Approximately 1,300 trees, of all species, were killed.

Glacier NP

Small groups DFB-killed DF were mapped in Kintla Creek, Bowman Creek, Logging Creek, and Nyack Creek drainages, and near north end of McDonald Lake. MPB-killed WWP was noted northwest of Flathead River Ranger Station, in the southern portion of the Park and also near Nyack Ranger Station, near Scalplock Mountain. A few groups of ESB-caused

mortality also observed in Nyack Creek drainage, near the Ranger Station. A few other small polygons of MPB-killed LPP, as well as damage from FE and DFB were observed throughout the Park, but most were insignificant. Fewer than 300 acres, total, were infested.

Flathead IR

Numerous groups of MPB-infested LPP stands were observed at various locations on the Reservation in 1996--northeast corner, east of Flathead Lake, northwest corner near Mill Creek, western edge between Hot Springs and Rainbow Lake, as well as along the southern portion from Clear Creek eastward to Ravalli. Also, numerous groups of PP, killed by WPB and MPB, were mapped in a scattered pattern throughout the Reservation. More concentrated groups were noted from south of Dixon to Lower Jocko Lake and northward from Mission Reservoir to Flathead Lake. A few groups of beetle-killed PP were also mapped west of Flathead Lake, a few miles southwest of Big Arm. Small, widely scattered groups DFB-caused mortality was found throughout DF type. Diplodia blight and elytroderma needle cast, and their interactions with bark beetles, continued to affect PP stands in several locations around Flathead Lake.

Throughout the Reservation, just over 1,700 acres contained trees killed by bark beetles. About 2,800 dead trees were recorded.

Crow IR

MPB-killed PP was found to be scattered in numerous small groups in the Wolf Mountains, east of Lodge Grass. Another concentration of beetle-caused mortality was observed in Owl Creek drainage, south east of Lodge Grass. Some incidence of IPS-caused damage was observed in those PP stands, as well. In the Pryor Mountains, some MPB-caused mortality was noted in PP stands in Shiver Creek and Pryor Creek drainages; while mortality attributed to WBBB was seen in upper Lost Creek drainage. A small amount of DF, killed by DFB was noticed near West Pryor Mountain. In total, about 200 acres were infested by the several bark beetles species observed.

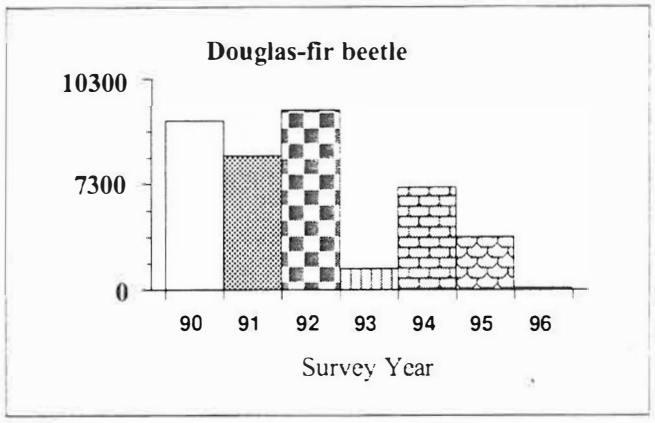
Rocky Boy IR

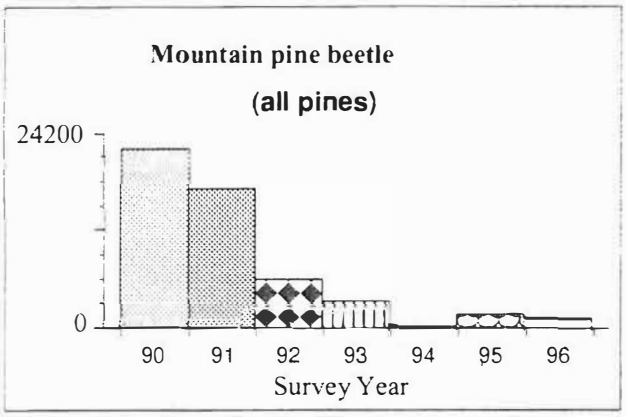
Numerous small groups of MPB-caused mortality in both LPP and PP stands was observed in the southern portion of the Reservation. MPB in PP was concentrated in Big Sandy and Muddy Creek drainages, south of Centennial Mountain. Some groups were of considerable size and may have been associated with heavy elytroderma infections. MPB in LPP stands was confined mostly to the Green Creek drainage, south of Black Mountain. Some PP stands, being impacted by MPB, was also mapped south of the Reservation boundary, on private land. Approximately 200 acres were infested, throughout the Reservation.

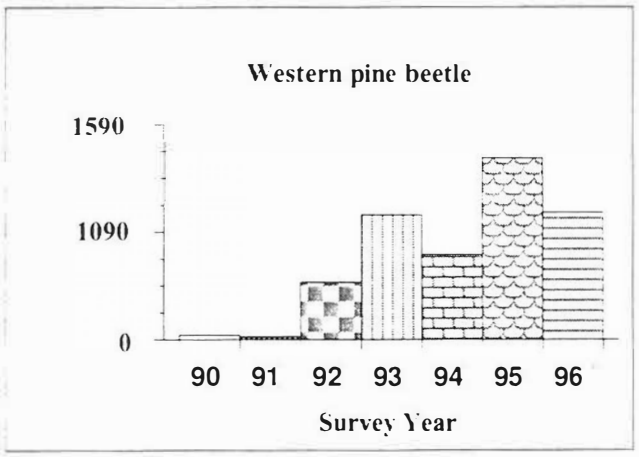
Fort Belknap IR

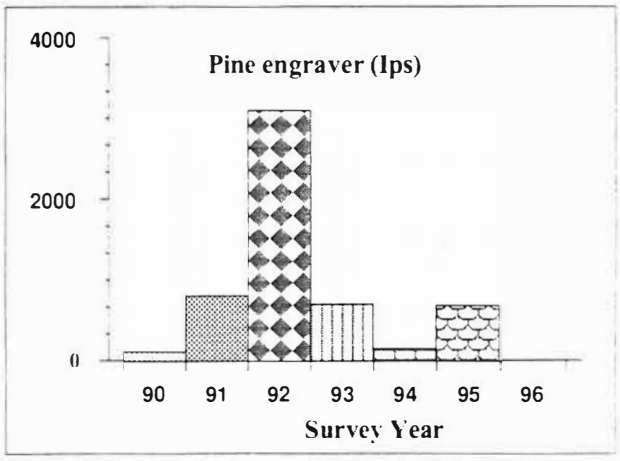
A number of widely scattered groups of MPB-killed PP were found near both Zortman and Landusky. Heaviest concentrations in were Beaver Creek, east of Beaver Mountain. Groups of up to 75 beetle-killed trees were mapped in that area. A few small groups of LPP, infested by MPB, were observed in the Little Rocky Mountains, north of Landusky. More than 1,100 acres were infested--over 1,000 of them being PP. More than 1,300 trees killed.

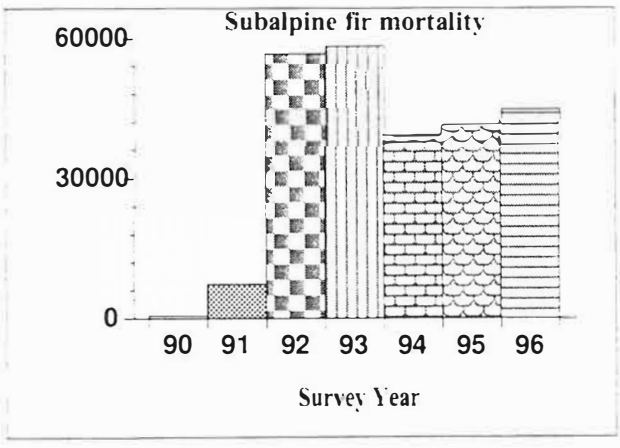
Bark Beetle Infestation Acres and Subalpine Fir Mortality Recorded During Aerial Surveys











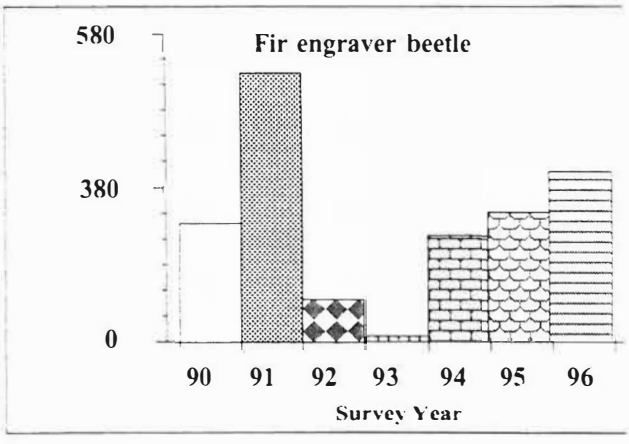


Table 2. Douglas-fir beetle-infested acres in Montana, all ownerships, from 1994 through 1996

	******* 1994 ********			******* 1995 ********			******* 1996 ********		
Reporting Area	Acres	Trees	Vol. (MBF)	Acres	Trees	Vol. (MBF)	Acres	Trees	Vol. (MBF)
Beaverhead NF	47	51	10.2	6	8	1.6	31	60	12.0
Bitterroot NF	166	351	105.3	64	121	36.3	145	121	36.3
Custer NF	672	793	158.6	102	256	51.2	663	456	91.2
Deerlodge NF	32	32	6.4	19	21	4.2	40	69	13.8
Flathead NF	1,629	3,869	1,160.7	746	1,823	546.9	477	1,199	359.7
Gallatin NF	1,182	1,164	232.8	224	502	100.4	737	1,612	322.4
Helena NF	996	1,354	270.8	1,421	1,082	216.4	322	636	127.2
Kootenai NF	1,272	2,547	764.1	554	1,434	430.2	321	797	239.1
Lewis & Clark NF	14	20	4	94	35	7.0	229	222	44.4
Lolo NF	624	1,221	366.3	455	622	186.6	899	1,773	531.9
Swan River SF	145	362	111.6	7	13	3.9	54	149	44.7
Stillwater SF	10	9	2.7	4	4	1.2	4	5	1.5
Thompson R. SF	28	78	23.4	0	0	0.0	23	46	13.8
Garnets	123	201	60.3	79	116	34.8	125	325	65.0
Flathead IR	166	438	131	95	156	46.8	197	118	35.4
Crow IR	*	*	*	8	10	2.0	9	11	2.2
Glacier NP	*	*	*	1,371	1,877	563.1	64	203	60.9
Yellowstone NP	*	*	*	549	880	176.1	*	*	---
Other	88	103	20.6	---	---		13	11	2.2
Total	7,194	12,593	3,429.2	5,798	8,960	2,408.7	4,353	7,813	2,003.7

*Not flown
MBF = 1,000 board ft

Table 3. Acres of mountain pine beetle caused mortality on state and private lands in Montana from 1994 through 1996.

	********** 1994 **********				********** 1995 **********				********** 1996 **********			
Reporting Area	**LPP1**	**PP**	**WBP**	**WWP**	**LPP**	**PP**	**WBP**	**WWP**	**LPP**	**PP**	**WBP**	**WWP**
Beaverhead NF	9	0	0	0	15	2	0	0	2	0	0	0
Bitterroot NF	0	269	0	0	14	428	0	0	0	291	0	0
Custer NF	0	2	0	0	2	42	0	0	4	4	0	0
Deerlodge NF	99	33	2	0	25	21	0	0	25	66	0	0
Flathead NF	191	36	0	49	195	461	2	130	76	10	0	26
Gallatin NF	49	0	32	0	2	0	17	0	119	13	0	0
Helena NF	34	132	2	0	143	290	15	0	39	179	6	0
Kootenai NF	53	20	0	70	416	109	0	60	90	34	0	34
Lewis & Clrk NF	2	337	0	0	11	389	0	0	89	953	7	0
Lolo NF	463	508	0	2	1,931	1,114	7	0	929	653	0	12
Stillwater SF	4	2	0	59	81	2	0	210	15	0	0	63
Swan River SF	0	2	0	14	2	0	0	0	13	0	0	50
Thompson R. SF	618	137	0	0	0	0	0	0	373	269	0	2
Garnets	6	174	0	0	17	374	0	0	12	2,029	0	0
Crow IR	*	*	*	*	*	*	*	*	0	48	0	0
Fort Belknap IR	*		*	*	*	*	*	*	0	17	0	0
No. Cheyenne IR	*	*	*	*	*	*	*	*	0	0	2	0
Rocky Boys IR	*	*	*	*	*	*	*	*	0	60	29	0
Flathead IR	*	*	*	*	*	*	*	*	0	466	0	0
Other	57	26	0	120	42	338	0	0	0	0	0	0
Total	**1,585**	**1,678**	**36**	**314**	**2,896**	**3,570**	**41**	**400**	**1,786**	**5,092**	**44**	**187**

[1] LPP = lodgepole pine; PP = ponderosa pine; WBP = whitebark pine; WWP = western white pine

* = Not flown

Table 4. Acres of mountain pine beetle caused mortality on Federal and Indian Reservation lands in Montana from 1994 through 1996.

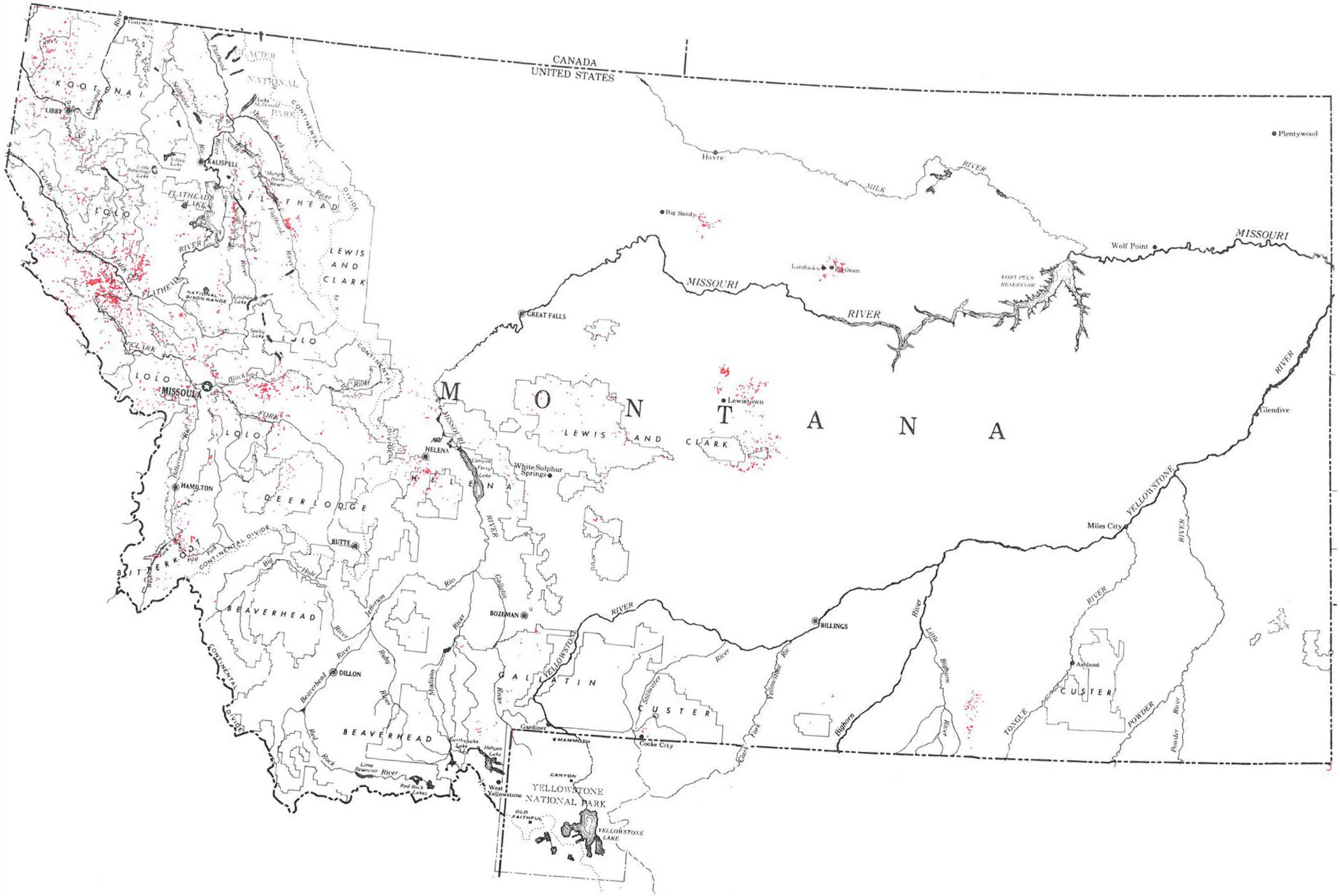
	1994				1995				1996			
Area	**LPP[1]**	**PP**	**WB P**	**WWP**	**LPP**	**PP**	**WBP**	**WWP**	**LPP**	**PP**	**WBP**	**WWP**
Beaverhead NF[2]	47	0	85	---	65	2	21	0	46	0	12	0
Bitterooot NF	4	214	0	0	37	366	0	0	48	340	0	0
Custer NF	87	0	30	---	0	266	0	0	1	0	6	0
Deerlodge NF	256	0	0	0	109	4	0	0	137	82	8	0
Flathead NF	1,375	96	47	330	1,729	78	21	479	965	6	31	224
Gallatin NF	164	2	320	---	20	0	118	0	134	0	99	0
Helena NF	94	76	16	0	508	221	58	0	126	216	25	0
Kootenai NF	1,244	109	6	974	2,941	121	8	1,002	672	53	2	378
Lewis & Clark NF	208	279	15	0	120	488	7	0	558	585	11	0
Lolo NF	7,438	677	40	88	11,465	1,836	27	152	11,629	1,487	7	178
Total NF	**10,917**	**1,453**	**559**	**1,392**	**16,994**	**3,382**	**260**	**1,633**	**14,316**	**2,769**	**201**	**780**
Crow IR[3]	*	*	*	*	0	8	0	0	2	101	0	0
Fort Belknap IR	2	22	0	0	*	*	*	*	86	1,045	0	0
Flathead IR	447	466	0	0	582	593	0	0	507	323	0	0
N. Cheyenne IR	*	*	*	*	0	210	0	0	0	0	0	0
Rocky Boys IR	0	14	0	0	20	8	0	0	58	46	0	0
Total IR	**449**	**502**	**0**	**0**	**602**	**819**	**0**	**0**	**653**	**1,515**	**0**	**0**
BLM (Garnets)	102	82	118	0	0	44	0	0	32	28	0	0
Glacier NP	*	*	*	*	55	2	2	537	24	0	0	60
Yellowstone NP	*	*	*	*	15	0	0	23	*	*	*	*
Total Federal (non-FS)	**551**	**584**	**118**	**0**	**672**	**865**	**2**	**560**	**709**	**1,543**	**0**	**60**
Total	**11,917**	**2,539**	**677**	**1,392**	**18,268**	**5,066**	**262**	**2,193**	**15,678**	**5,827**	**201**	**840**

[1]LPP = Lodgepole pine; PP = ponderosa pine; WBP = whitebark pine; WWP = western white pine
* = not flown
[2]NF = National Forest
[3]IR = Indian Reservation

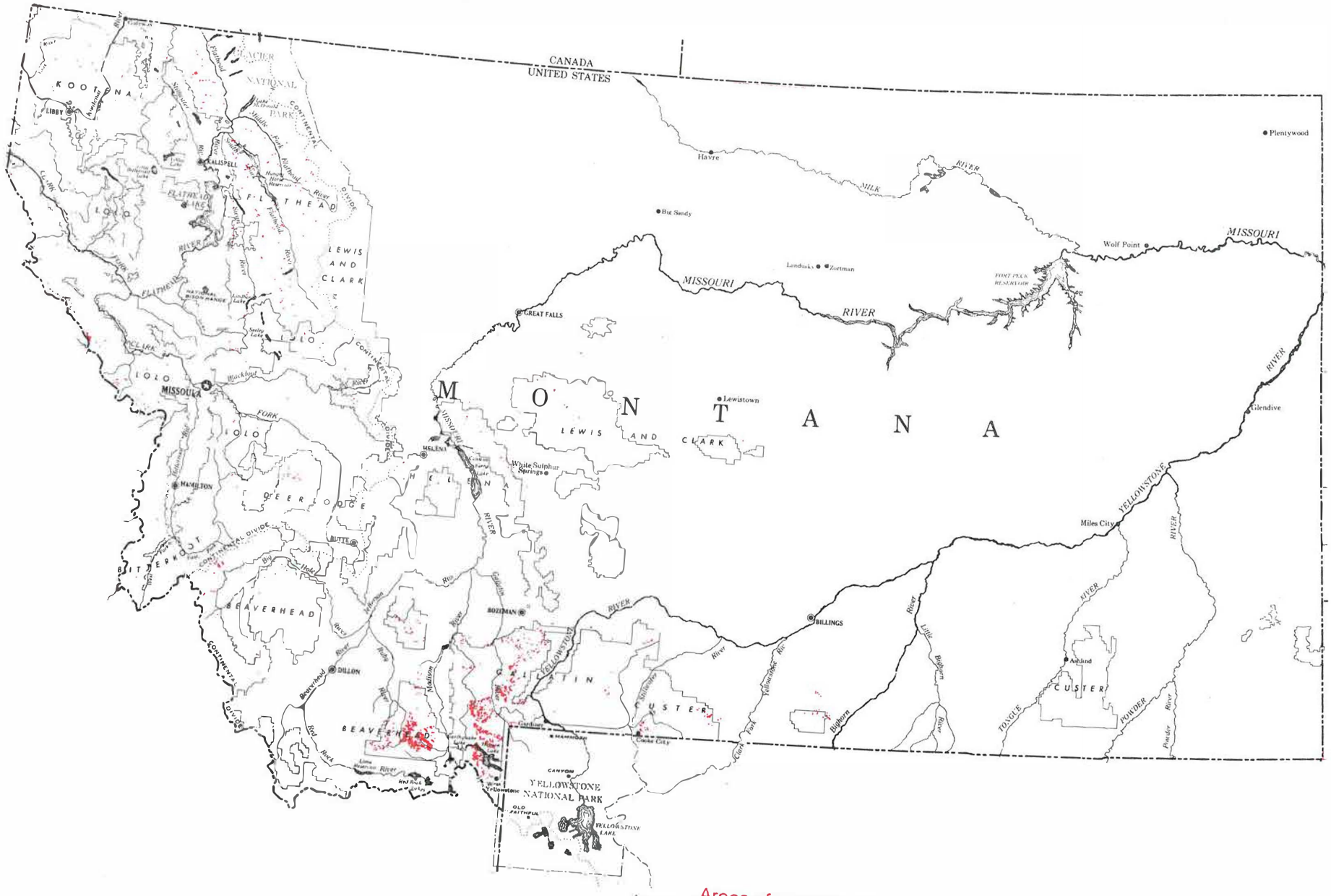
Table 5. Bark beetle infested acres (other than mountain pine beetle and Douglas-fir beetle) in Montana

	Engelmann Spruce Beetle			Pine Engraver Beetle			Western Pine Beetle			Fir Engraver Beetle			Western Balsam Bark Beetle **		
Reporting Area	1994	1995	1996	1994	1995	1996	1994	1995	1996	1994	1995	1996	1994	1995	1996
Beaverhead NF	0	---	2	57	0	0	---	---	---	0	---	---	17,447	18,381	18,359
Bitterroot NF	0	2	6	0	156	0	196	212	199	2	14	0	42	42	30
Custer NF	14	---	324	0	49	0	---	---	0	0	---	---	369	166	472
Deerlodge NF	0	11	0	0	14	0	0	17	25	6	---	---	177	32	93
Flathead NF	40	72	272	0	36	0	32	92	73	58	59	113	194	392	816
Gallatin NF	138	204	396	831	112	0	---	---	---	0	---	---	19,749	20,888	24,223
Helena NF	8	22	14	0	35	0	---	---	---	0	---	---	183	844	143
Kootenai NF	0	---	4	2	34	0	56	181	128	38	65	29	56	297	50
Lewis & Clark NF	41	11	8	185	637	0	---	---	---	150	192	---	842	235	282
Lolo NF	6	11	129	57	2,896	0	417	2,016	479	0	0	179	206	207	131
Garnets	0	---	0	0	549	0	0	137	0	0	17	0	4	8	4
Flathead IR	2	---	2	0	1,983	0	176	102	159	0	---	31	20	34	16
N. Cheyenne IR	*	4	0	231	231	0	*	---	---	36	0	---	*	*	0
Rocky Boys IR	*	*		*	*	2	*	*		*	*		*	*	0
Crow IR	*	*		*	*	10	*	*	---	*	*		*	*	35
Stillwater SF	0	4	2	0	0	0	1,200	0	0		2	6	0	23	4
Swan River SF	0	0	4	0	0	0		2	0		0	4	0	0	6
Thompson River SF	0	0	0	0	0	0	*	0	50	4	0	36	2	0	2
Glacier NP	*	*	103	*	*	0	*	*	2	*	*	2	*	*	6
Yellowstone NP	*	*	*	*	*	0	*	*	*	*	*	---	*	*	*
Total	**249**	**341**	**1,266**	**1,363**	**6,732**	**12**	**2,077**	**743**	**1,115**	**294**	**349**	**400**	**39,291**	**41,549**	**44,672**

* Not flown
**Mortality in subalpine fir



Areas of mountain pine beetle infestations in Montana (all host species), 1996


CANADA
UNITED STATES
MONTANA
KOOTENAI
GLACIER NATIONAL PARK
CONTINENTAL DIVIDE
LIBBY
KALISPELL
FLATHEAD
LEWIS AND CLARK
LOLO
FLATHEAD IRS
NATIONAL BISON RANGE
MISSOULA
BITTERROOT
HAMILTON
DEERLODGE
BUTTE
BEAVERHEAD
DILLON
HELENA
GREAT FALLS
Havre
Big Sandy
Landusky
Zortman
Wolf Point
Plentywood
MISSOURI
RIVER
MILK
FORT PECK RESERVOIR
Lewistown
White Sulphur Springs
Glendive
YELLOWSTONE
Miles City
BOZEMAN
GALLATIN
BILLINGS
Big Horn
Tongue
Powder
CUSTER
Ashland
Cooke City
Gardiner
YELLOWSTONE NATIONAL PARK
OLD FAITHFUL
YELLOWSTONE LAKE
CANYON
Areas of subalpine fir mortality caused by western balsam bark beetle and other agents in Montana, 1996.

Defoliators

Douglas-fir Tussock Moth

Douglas-fir tussock moth populations continue to be very low in Montana. No defoliations was detected from aerial surveys or from ground surveys. The Montana Department of Natural Resource and Conservation, Division of Forestry installed 33 pheromone trapping locations in 1996 across western Montana. Only eight moths were caught; four near Jette Lake, two at Pistol Creek, south of St Ignatius, one near Big Arm and one at Butler Creek north of Frenchtown.

Gypsy Moth

Over 1,300 gypsy moth (Lymantria dispar) detection traps were placed by USDA Forest Service, Animal and Plant Health Inspection Service (APHIS), Montana Department of Agriculture, and the Montana Department of Natural Resources and Conservation in 1996. The Montana Department of Natural Resources and Conservation caught a total of six gypsy moths in the detection traps placed in the city of Missoula, Montana. Five moths were found in one trap and another moth was found in a trap one mile away. All six moths were sent out for genetic testing which concluded that all six were of the European strain. Intensive delimitation trapping surveys for southeast Missoula are planned for 1997. No other moths were detected in the state of Montana.

Western False Hemlock Looper

For the second consecutive year, aerial surveys detected current defoliation from the western false hemlock looper in Douglas-fir stands on the same 97 acres. Three polygons were defoliated on the Helena National Forest (NF), two polygons northeast of the city of Helena and one polygon south of Helena. Less defoliation, insect larvae and pupae, were found in 1997 than 1996. This was probably a function of less available forage and a declining looper population. At one site, numerous pupae were parasitized by both hymenopeteran and dipterous parasites contributing to the overall looper decline. Significantly less defoliation is expected in 1997 based on other observations of looper "outbreak" population dynamics. During the summer of 1997, we will measure tree mortality in the defoliated areas and report our findings next year.

DISEASES

Root Diseases

Annosum Root Disease

Annosum root disease in ponderosa pine has been positively identified on the Flathead Indian Reservation; Lolo National Forest (NF), Missoula Ranger District (RD) and Ninemile RD; Bitterroot NF-Darby RD; and Kootenai NF-Cabinet RD. The presence of annosum root disease has significant implications regarding management of ponderosa pine, especially old growth ponderosa pine. There are circumstances that warrant stump treatments to prevent further spread of the disease at the time of cutting. Our unit is in the process of preparing a white paper addressing the management of ponderosa pine influenced by the presence of annosum root disease. General guidelines for stump treatments will be emphasized. A draft of this paper should be available spring 1997.

Tomentosus Root Disease

Tomentosus root disease was positively identified in service trips to the Gallatin NF and Flathead NF this year. Our office received a number of inquiries about this disease shortly after the distribution of the written trip reports. Tomentosus root disease is relatively common in the Region. It has been observed in a number of conifer species, but appears to cause the most damage and mortality in Engelmann spruce. It has been observed acting as a very aggressive root pathogen in Engelmann spruce in at least one area in the Region. tomentosus is also commonly found as a root and butt decay in lodgepole pine, subalpine fir and Douglas-fir. Root disease patch mortality does occasionally occur, but what is more commonly found is extensive root and butt decay which often leads to windthrow. Infected trees are also commonly attacked by bark beetles.

Needle Diseases

Larch needle cast (Meria laricis) and larch needle blight (Hypodermella laricis) were severe in 1996 along the Bitterroot Divide from Lolo Pass to Heron

and within the Middle Fork of the Flathead River drainage.

Rusts

Juniper-hawthorne rust (Gymnosporangium spp.) was very severe in the native hawthorne along the Hwy 200 corridor from Perma to Noxon in northwestern Montana. Although the disease symptoms were highly visible and severe defoliation occurred, permanent damage to the hawthorne in the area is not expected.

Diseases of Nurseries, Ornamentals and Tree Improvement Areas

1. Root decay caused by *Cylindrocarpon destructans* and other *Cylindrocarpon* spp. continued to be a problem on container-grown western white pine seedlings at the Plum Creek Nursery near Pablo, MT. Diseased seedlings often do not show above-ground symptoms and outplanting infected seedlings may result in poor performance.

2. Meria needle cast (caused by *Meria laricis*) was extensive during the spring, but bareroot western larch stock recovered during the summer when warm, dry weather occurred. This disease rarely kills seedlings or young trees, but may adversely affect their growth when epidemics occur.

Common and recurring nursery diseases:

1. Root diseases caused by *Fusarium* spp. conttinued to be the most important and damaging diseases of conifer bareroot and container-grown seedlings in Montana. *Fusarium oxysporum* is the most common pathogen of bareroot seedlings and is usually controlled by soil fumigation. *Fusarium proliferatum* is most important in greenhouses and spreads rapidly during the growth cycle. Sterilizing seed, containers, and greenhouse interiors help reduce damage from this pathogen.

Other *Fusarium* species may occasionally be important, particularly on unusual crops; much primary inoculum is seedborne.

2. *Botrytis cinerea* is a continual problem on many different conifer species grown within greenhouses. Damage varies from year to year and sone conifer species (Douglas-fir, lodgepole pine, and western larch and western redcedar) are more susceptible to this pathogen. Damage has particularly been limited by timely applications of preventative fungicides. However, recent efforts have been directed toward implementing biological control to reduce use of chemical pesticides and the change for developing resistant pathogen strains.

3. Water molds caused by several *Pythium* spp. recur in bareroot nurseries, particular during very west periods or in portions of the nursery that have drainage problems. Damage is usually small and can be prevented by providing proper drainage or by spot application of specific fungicides.

1996 SPECIAL PROJECTS

IPS PINI Technology Development Project (TDP) - 1996

Summary: In 1996, we (Forest Health Protection and Idaho Department of Lands) tested the efficacy of pairs of ipsenol and verbenone bubble capsules in protecting ponderosa pine slash piles from attack by pine engravers. Treatments consisted of 0, 10, and 20 bubble-cap pairs (one each bubble capsule of ipsenol and verbenone constituting a "pair.") Fresh slash piles--ponderosa pine logs 10 feet long, at least 3 inches diameter at small end, and with branches attached--were created in mid-April. The bubble caps were stapled to the top of wooden stakes, arranged in two concentric rings, surrounding the piles. The inner ring was approximately one foot from the edge of the pile, and the stakes were one foot tall. The outer ring was three feet from the pile's edge, with stakes three feet tall. The test was duplicated in western Montana, and northern Idaho. At each site, there were six replications--a total of 18 piles at each site. Piles were a minimum 50 meters apart. Funnel traps, baited with pine engraver attractants (ipsdienol and Lanierone), were placed throughout the treatment area to monitor beetle flight.
Slash piles were observed weekly and frass piles were counted and marked with colored push pins. Each week's observations were marked with different colored pins. Initial beetle flight was completed in mid-June and treatment effects were evaluated in late June to early July. Treatment effects were assessed by counting successful engraver beetle attacks beneath four, 6-inch square, bark samples removed from each log.

Results: Pine engraver attacks per treatment:

Treatment	Montana	Attacks/Sq.Ft.	Idaho	Attacks/Sq.Ft.	Combined	Attacks/Sq.Ft.
Check	416	10.67	356	8.48	772	9.53
10 Pairs	60	1.50	1	0.02	62	0.74
20 Pairs	5	0.13	0	0	5	0.06

We determined weekly attack counts did not provide meaningful data because of confusion from attacks by other secondary bark beetles.

Recommendations: Because of excellent results obtained from this "mix" of pheromones, we believe it is now time to develop a more feasible operational method of using them. In 1997, we will test deployment of pheromone pairs in a more operational setting--that of trying to keep broadcast slash from being attacked. Future tests may include different deployment devices, such as polymer beads or flakes.

Insects Affecting The Reproduction Of Whitebark Pine In The Western United States

During 1996, Sandy Kegley and Nancy Campbell, in cooperation with other western entomologists in Region's 4,5 and 6, completed a study to examine the insect complex affecting the reproduction of whitebark pine.

Cones were collected from treatment trees at all sites and the insects associated with the cones were reared in the lab. The cones were then examined for both internal and external damage from insects. All seeds were x-rayed for insect damage as well.

The results of this study will provide information on which insects are associated with cones and seeds of whitebark pine, the amount of damage they cause, and at what time of the year the insects are actively causing the damage. Significant cone insects found so far include *Dioryctria abietivorella* (cone worm), *Conophthorus ponderosae* (cone beetle), and *Leptoglossus occidentalis* (seed bug) In western white pine, both of these insects can have a significant impact on cone and seed production.

Further results and a report will be published later this year. If you have any questions about this project or the results, contact Sandy Kegley or Nancy Campbell.

Western Spruce Budworm Permanent Plots

Permanent plots on the Beaverhead, Bitterroot, Deerlodge, Lewis & Clark, Lolo, Helena and Nez Perce National Forests were re-measured for defoliation and budworm population estimates in 1996. Light defoliation was seen in a few stands east of the continental divide. In 1997, trees in plots established in 1992 will be re-measured for new height and diameter growth. Any new insects and diseases present will also be recorded.

All permanent plots will be monitored annually for defoliation and damage over the long term for budworm effects on ecosystem structure and function and for model validation.

Annosum Root Disease Project on the Flathead Indian Reservation

An ongoing project looking at ponderosa pine decline on the Flathead Indian Reservation is in its 4th year. Third year mortality readings (1996) found no new mortality in the 1011 tagged ponderosa pine trees. First and second year readings found only two and three newly dead trees, respectively. Heterobasidion annosum, causal agent of annosum root disease, was positively identified in two of these trees, and highly suspected in the remaining three trees. These early results indicate a lower mortality rate than was expected. This low rate may be tied to the trees recovering from the drought experienced in the area in the 1980's.'

Limber Pine Decline (Update)

A series of transects were established on the Lewis and Clark National Forest (NF) in 1996 for the purpose of monitoring the limber pine decline situation (see p.19, Rpt 96-2). Four transects were established on the forest with a total of 248 trees. All trees received a metal tag and were evaluated for growth and health attributes including height, diameter, insect and disease damage, and a crown health rating which consisted of an estimate of needle length, needle retention, and needle color. The transects will be remeasured in 1997. After that they will be remeasured every two years or more, depending on findings from the 1997 measurements. Contact people for this project are Nancy Campbell and Jane Taylor, Forest Health Protection in Missoula, and Glenda Scott on the Lewis and Clark NF.

Nursery Disease Projects

1. Alternatives to chemical soil fumigation for control of soil-borne diseases in bareroot forest nurseries.
   - this multi-regional project was initiated in 1993 in response to the proposed elimination of methyl bromide as a soil fumigant by the year 2001. Soil treatments were established in two USDA Forest Service nurseries in Idaho (Coeur d'Alene and Lucky Peak near Boise). Treatments include several organic amendments and fallowing compared to standard chemical soil fumigation. The first round of tests concluded in the fall of 1995 on some species and in the spring of 1996 with others. Some treatments were repeated in different portions of the nurseries beginning in 1996. Most organic amendments stimulated potentially pathogenic populations of Fusarium, even though differences in disease and healthy seedling production was not always found. Fallowing with periodic cultivation appeared the most promising alternative treatment and often resulted in seedling production similar to the fumigated plots.
   - another portion of this project deals with genetic studies to determine pathogenic characteristics of the most common and important soil-borne pathogen in many nurseries, Fusarium oxysporum. Using state-of-the-art molecular techniques, investigators are evaluating the potential of rapidly locating pathogenic strains of the fungus from both soil and seedling samples and relating this to other work such as pathogenicity testing, vegetative compatibility grouping, and isozyme analyses. This work is being conducted in cooperation with the University of British Columbia and Oregon State University.

2. Epidemiology of Cylindrocarpon spp. on container-grown conifer seedlings.
   - investigations were continued to characterize fungal species involved in disease, assess pathogenicity, and formulate procedures to reduce losses. An evaluation to investigate fate of Cylindrocarpon spp. on outplanted white pine seedlings and their role on seedling performance continued in cooperation with the University of Idaho and Potlatch Corporation.

3. Pathogenic potential of Fusarium spp. on conifer seedling.
   - work continued to screen isolates obtained from soil, diseased and healthy seedlings for virulence against conifer germinants to characterize populations. This was especially important in association with the alternatives to soil fumigation work so that growers can estimate what proportion of the resident Fusarium population may actually be pathogens and of concern.

4. Biological control of nursery root and foliage diseases.
   - work continued to evaluate commercial and non-commercial formulations of biocontrol organisms to reduce impact of root diseases in bareroot nurseries. Several fungal and bacterial formulations

are being evaluated to reduce root diseases and may be used in combination with other treatments to replace chemical soil fumigation. Another potential biocontrol agent is being evaluated to determine its efficacy to control Botrytis blight in container nurseries.

5. Evaluation of the efficacy of dazomet chemical soil fumigation at the USDA Forest Service Lucky Peak Nursery.

· work continued to evaluate dazomet as a soil fumigant to replace methyl bromide at this nursery.

The evaluation will be concluded in the fall of 1997 when treated fields are evaluated

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APPENDIX

COMMON AND SCIENTIFIC NAMES

Diseases

Annosus root disease	*Heterobasidion annosum* (FR.) Bref.	Primary hosts: DF, GF, PP, SAF
Armillaria root disease	*Armillaria ostoyae* (Romagn.) *Herink*	DF, GF, SAF, sapling pines
Atropellis canker	*Atropellis piniphila* (Weir) Lohn. and Cash	LPP
Brown cubical butt rot	*Phaeolus schweinitzii* (Fr.) Pat.	DF
Comandra rust	*Cronartium comandra* Peck.	LPP, PP
Diplodia blight	*Sphaeroposis sapinea* (Fr.) Dyko.	PP
Dutch elm disease	*Ceratocystis ulmi* (Buism.)	American elm
Dwarf mistletoes	*Arceuthobium* spp.	LPP, DF, WL
Brown stingy rot	*Echinodontium tinctorium*	GF, WH
Elytroderma needle cast	*Elytroderma deformans* (Weir) Darker	PP
Fusarium root rot	*Fusarium oxysporum* Schlect.	DF (Nursery)
Grey mold	*Botrytis cinerea* Pers. Ex Fr.	WL (Nursery)
Larch needle blight	*Hypodermella laricis* Tub.	WL
Larch needle cast	*Meria laricis* Vuill.	WL
Laminated root rot	*Phellinus weirii* (Murr.) Gilb.	DF, GF, WH, SAF
Lodgepole pine needle cast	*Lophodermella concolor* (Dear.) Dark	LPP
Pini rot	*Phellinus pini* (Thore:Fr.) Pilet.	DF, WL, ES, All pines
Sirococcus tip blight	*Sirococcus strobilinus* Preuss	WWP (Nursery)
Swiss needle cast	*Phaeoeryptopus gaeumannii* (Rhode)	DF
Western gall rust	*Endocronartium harknessii* (Moore) Hirta.	LPP, PP
White pine blister rust	*Cronartium ribicola* Fisch.	WWP, WBP
Rhabdocline needle cast	*Rhabdocline pseudotsugae* Syd.	DF

Insects

Douglas-fir beetle	*Dendroctonus pseudotsugae* Hopkins	DF
Douglas-fir tussock moth	*Orygia pseudotsugata* (McDunnough)	DF, TF, ES
Gypsy moth	*Lymantria dispar* (Linnaeus)	Most hardwoods
Mountain pine beetle	*Dendroctonus ponderosae* Hopkins	all pines
Pine engraver beetle	*Ips pini* (Say)	PP, LPP
Spruce beetle	*Dendroctonus rufipennis* (Kirby)	ES
Western balsam bark beetle	*Dryocoetes confusis* Swaine	SAF
Western spruce budworm	*Choristoneura occidentalis* Freeman	DF, TF, ES, WI
Western pine beetle	*Dendroctonus brevicomis* LeConte	PP
Fir engraver beetle	*Scolytis ventralis* LeConte	GF, SAF
Lodgepole terminal weevil	*Pissodes terminalis* Hopping	LPP
Balsam woolly adelgis	*Adelges piceae* (Ratzeburg)	SAF, GF
Pine tussock moth	*Dasychira plagiata*	PP
Sawflies	*Neodiprion autumnalis*	PP
Tip moth	*Rhyacionia* species	PP

DF = Douglas-fir; GF = Grand fir; TF = True fir; SAF = Subalpine fir; PP = Ponderosa pine; LPP = Lodgepole pine; WWP = Western white pine; ES = Engelmann spruce; WH = Western hemlock; WL = Western larch; MH = Most hardwoods; WRC = Western redcedar; WBP = Whitebark pine

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